

## CURRENT ACTIVITY OF U.S. ASTER SCIENCE TEAM

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The U.S. ASTER Science Team is currently engaged in numerous ASTER-related activities, many of them jointly with our Japanese colleagues. These include vicarious instrument calibration, algorithm development and validation for higher level data products, assistance to ERSDAC for scheduling activities (primarily for U.S. users), assistance to data users other than Science Team members, and science applications of ASTER data, notably in the areas of glacial monitoring, volcanic monitoring, heat balance determinations, geologic mapping, and cloud studies.

The U.S. Team members are working jointly with Japanese Team members on vicarious calibration/validation exercises at test sites in both Japan and the U.S. Results are discussed at the ASTER Calibration Team meetings, where some changes have been made in the calibration coefficients for the VNIR/SWIR. Problems with the SWIR crosstalk have been discussed, and we are now in the process of evaluating the latest correction algorithm developed in Japan.

In addition, several sites have been established that acquire all the necessary measurements on an automated basis to enable the validation of the thermal infrared data and products from ASTER. The accuracy of the ASTER Level 1B radiance at sensor has been determined and work is continuing on validating data from the ASTER level 2 surface radiance, surface temperature and surface emissivity products. Preliminary results indicate that under ideal conditions the surface temperature and emissivity products meet specification. The results also indicate that the calibration accuracy of the ASTER thermal channels has been maintained in-flight thus far. The sites have also been used to validate data from other instruments and cross-compare these with ASTER. This work will provide a mechanism to allow inter-comparison of ASTER data with data from other instruments.

In the science area, the data acquisition for the various STARs is producing many exciting new results. New ASTER VNIR, SWIR, and TIR observations of over 1000 volcanoes around the world represent a quantum increase in our ability to monitor volcanic activity and to map the products of eruptions. Of key importance is the ability to compile time-series data on volcanic precursor activity, as well as to make sequential observations during an eruption. In particular, ASTER's greater dynamic range (with respect to Landsat TM) allows collection of unsaturated data from high temperature targets (e.g., lava flows, summit craters, and domes), and ASTER stereo photogrammetric capability for the first time permits acquisition of systematic topographic data. The July-August 2001 eruption of Mt. Etna in Italy, the world's best and most studied natural volcanological laboratory, provides a good illustration of these unique ASTER eruption-monitoring capabilities. Clear pre-, syn-, and post-eruption ASTER images were acquired, including both day and night frames. Daytime before-

and-after VNIR frames permitted the planimetric mapping of lava flow areal extent, and SWIR frames permitted mapping of hot areas and estimates of thermal flux in incandescent zones within flows (typical ASTER-derived pixel integrated temperatures ~250°C-350°C for active flows). Human lava flow diversion activities are evident at 15m/pixel spatial scale of the VNIR data. In addition, ASTER-derived DEMs allow quantitative documentation of the new summit crater topography, as well as topographic analyses of lava flow thicknesses, and thus volumes for accumulations greater than 8-10m thick. Using ASTER topographic measurements of this and previous eruptions of lava into the prodigious Valle del Bove, calculations are underway to estimate the thickness of lava accumulations within that structure. Topographic observations are important in trying to understand the cumulative buildup of stress due to both asymmetric lava flow deposition (i.e. preferentially within Valle del Bove), as well as in undertaking similar measurements of mass loading due to previous lava flow emplacement. Such measurements and associated models are important in trying to understand potential volcanic mass movement hazards and their potential effects on surrounding communities. Likewise, ASTER provides detailed multispectral observations of the spectral signatures of airborne ash and SO<sub>2</sub> plumes, which represent a severe hazard to local aircraft and which are difficult to track under cloudy conditions. ASTER observations of the July-August 2001 eruption of Mt. Etna were carried out in conjunction with a MIVIS airborne 102 channel VNIR-SWIR-TIR scanner deployment by the Italian National Research Council and the National Institute for Geophysics and Volcanology, thus providing an opportunity to cross check and calibrate both data sets. Over its mission lifetime ASTER will continue to take advantage of the accessibility and logistical support at Mt. Etna, and will compile a systematic image data base to document volcanological changes as they occur.

Other volcanological research using ASTER data is currently examining night-time SWIR and TIR data at Montserrat and Bezymianny volcanoes. Collaborations with the Alaska and Montserrat Volcano Observatories, the Universities of Hawaii, and the University of Reading and the Open University (both in England) have been instrumental in gaining ground- and satellite-based data to correlate the ASTER data. Specifically,

ASTER data has been compared to GOES and AVHRR radiance data, with the higher spatial resolution of ASTER revealing much more detail in the dome structures. The next phase of this research will be examining the changes in surface texture of the domes derived from the ASTER TIR emissivity data. This is also showing promising results and will be presented at a special session of the Fall AGU Meeting (New Volcanological Results from the EOS Instruments).

In the area of glacial monitoring, the Global Land Ice Measurements from Space project (GLIMS) is progressing well. GLIMS objectives are to establish a global inventory of land ice, including surface topography, to measure the changes in extent of glaciers and, where possible, their surface velocities. This project is designed to use primarily data from ASTER, and the monitoring activities are expected to continue through the life of the ASTER mission. This work will also establish a digital baseline inventory of ice extent for comparison with inventories at later times.

It is estimated that the GLIMS goals can be achieved with access to less than one percent of ASTER's downlink capability.

The number of glaciers in the world is not well known. Two large digital inventories [World Glacier Monitoring Service (WGMS) and Eurasia at the National Snow and Ice Data Center (NSIDC)] have been combined and total about 80,000 glaciers. These inventories include latitude, longitude, an estimate of glacier area, and for some glaciers a large number of scalar parameters describing the size and condition of the glacier. The objective of the GLIMS project is a GIS database capable of measuring changes in individual glaciers. To our knowledge, this type of GIS does not exist, except for limited regions. For ice masses of 0.1 square kilometers or larger, existing inventories are probably incomplete by a factor of several.

The basic plan is image acquisition on an annual basis, using an average of 3 to 5 imaging attempts per year for all GLIMS targets. Highly automated software to detect and map ice margins and surface feature velocities is being developed by the GLIMS group. The international glaciological community has been asked to collaborate in this development and in mission planning and data analysis.

Evaluation of an ASTER image of the Mountain Pass, Calif. area indicates that several important lithologic groups can be mapped in areas with good exposure using spectral-matching techniques. The three visible and six short wavelength infrared bands, were calibrated by using in situ measurements of spectral reflectance. Matched-filter processing in which image spectra were used as reference for selected endmembers resulted in distinction of calcitic rocks from dolomitic rocks. Skarn deposits and associated bright coarse marble were mapped in contact zones related to intrusion of Mesozoic and Tertiary granodioritic rocks into Paleozoic carbonate strata. Fe-muscovite, which is common in these intrusive rocks, was distinguished from Al-muscovite present in granitic gneisses and Mesozoic granite. Analysis of the 5-band surface spectral emissivity data, which is now produced as a standard product at the EROS Data Center, showed that quartzose rocks were readily discriminated, and carbonate rocks were mapped as a broad single unit. Three additional broad classes resulting from spectral-angle mapper processing ranged from a broad granitic rock class, to predominately granodioritic rocks, and a more mafic class consisting mainly of mafic gneiss, amphibolite, and variable mixtures of carbonate rocks and silicate rocks which result from the 90-m resolution of the TIR data.

Excellent ASTER scenes over our Jornada New Mexico test site were acquired on May 9, 2000, February 12, 2001, May 12, 2001, July 22, 2001, September 17, 2001, and October 19, 2001. There were simultaneous field campaigns for the 5/09/00, 5/12/01 and 9/17/01 scenes. Also, MASTER coverage was obtained for the 5/12/01 scene, the scheduled 9/17/01 coverage was not acquired due to the national emergency. The White Sands National Monument was also within several of the scenes. Emissivity values from the ASTER data from the 5/09/00 and 5/12/01 scenes for the gypsum sand at White Sands were in good agreement with values calculated from the lab spectra for gypsum and with each other except for band 10. At the Jornada grass site the agreement between the ASTER results and those calculated from the lab spectra is very good. This is a little surprising because there is generally a mix of bare soil and senescent vegetation at this site so that we would have expected to see a flatter spectral response due to the vegetation. The results for the Jornada mesquite site show a larger difference between the lab results and the ASTER results, e.g. 0.05 for the 8.29 micron channel. These results indicate ASTER and TES are working very well.

Several ASTER scenes of the El Reno, Oklahoma area were obtained during the fall 2000 (9/04, 9/27 and 11/21) and in the summer of 2001 (6/10, 7/12, and 7/28). Most of these scenes were acquired for the CART-ARM site which is 150 km north of our site. While there were no field campaigns to support these acquisitions there was fortunately one flux station operating so we will be able to use these data to further study the scaling issues. Preliminary results with the fall 2000 data indicate that the ASTER data work very well with 2-source model and that the flux estimates are in reasonable agreement with the ground measurements.

Another project is focused on arid land processes and hazard assessments. ASTER has collected data over 70% of the Arid Lands Monitoring (ALM) STAR. Data over the global deserts is being used for mapping sediment transport and environmental degradation. The ALM research project is using ASTER to examine the hazards associated with arid lands brush fires and subsequent flooding.

Other uses of ASTER data include mapping of urban development, hazard monitoring, and land use change detection.

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